

REMARKS

By this amendment the objection noted by the Examiner of claim 1 due to informalities has been corrected.

Claims 1-6 and 9-16 were rejected. Claims 7 and 8 were objected to, but would be allowable if incorporated into a base claim. As will be discussed below, it is believed that the independent claim sets forth allowable subject matter.

Claims 1, 6, 12, 13, and 16 are rejected under 35 USC § 102(b) as being anticipated by Matsuura et al. (US 5,516,577). It is respectfully submitted that Matsuura et al., hereinafter referred to as "Matsuura", do not anticipate the present invention.

The Examiner stated that the claimed adhesion-promoting layer reads upon the "adhesion layer" of Matsuura. Matsuura et al. specifies that the adhesive layer comprises compounds such as bis(benzo-8-quinolinol)zinc (column 17, lines 12-13). Applicants submit that Matsuura et al. is limited to organic-metallic compounds of 8-hydroquinoline or derivatives thereof (column 16, lines 47-49). Amended claim 1 excludes the use of organic metal compounds in the adhesion-promoting layer. Claim 1, as amended, requires inorganic materials. In the present specification, examples of are given of inorganic transition metals or inorganic transition metal compounds. In light of this distinction it is believed that claims 1, 6, 12, 13, and 16 are not anticipated by Matsuura et al.

The present invention relates to the situation where the cathode is substantially pure Mg. Although pure Mg may be mentioned for use as a cathode, in Matsuura et al., Applicants have discovered that this is very difficult, because pure Mg does not adhere well to an underlying organic layer. This situation is discussed on pages 1 and 2 of the Background of the Invention of the present application. The object of the present invention is to provide an OLED with substantially good adhesion between a substantially pure Mg cathode and the underlying organic structure. It has been discovered that when the adhesion-promoting layer has at least one metal or metal compound selected from group 1 through group 15 of the periodic table, and such metal has an atomic number of at

least 19, improved adhesion between a substantially pure Mg cathode and the organic structure can be achieved.

Although Matsuura et al. states in the background of his invention that Mg can be used as a cathode they do not recognize that Mg has an adhesion problem. Moreover, their adhesion promoting layer is made of organic materials. No examples are given where Mg is deposited as the cathode and no results are discussed. It appears to be unlikely that Matsuura et al. completed any experiments with the use of pure Mg as a cathode. Matsuura et al. do use a Mg alloy, but that is not pure Mg. Mg alloys have less of an adhesion problem than pure Mg. Clearly the present invention solves the pure Mg adhesion problem and this solution is not in any way suggested by Matsuura et al. The mere mention in the background that Mg has been used as a cathode does not provide any motivation for the present invention. The Matsuura et al. invention has nothing to do with the use of Mg. Moreover, in the Matsuura et al. detailed description, it is not even mentioned. Therefore, it is respectfully submitted that the adhesion-promoting layer disclosed in the present invention is not anticipated by Matsuura et al.

The Examiner rejected claims 1, 5 and 12-16 under 35 USC § 102(b) as being anticipated by Namiki et al. (US 5,457,565). It is respectfully submitted that Namiki et al., hereinafter referred to as "Namiki", do not anticipate the present invention.

The Examiner stated that the adhesion-promotion layer featured in the present layer was read upon by the Namiki disclosure of an electron-injecting layer made of at least one alkaline earth metal oxide, such as SrO, CaO, or BaO and having a thickness of 1-10 angstroms. Applicants respectfully submit that although Namiki mentions the same materials for the electron-injecting layer, in the detailed description of the invention, their cathodes are all high work-function materials (greater than 4.0 eV) and there would be no motivation to use their electron injection layer with a pure Mg cathode.

In column 1 of Namiki discussing the prior art, they briefly mention that the cathode can be made of a number of materials including Mg. This is just another general discussion and they do not use substantially pure Mg

as their cathode. In discussing preferred embodiments of their inventions (Columns 3 and 4), they do not use a substantially pure Mg cathode, but only use metals and metal compounds such as Al, ITO, and SnO₂. Furthermore, the examples given by Namiki disclose only the use of Al as a cathode. Clearly, the electron injecting layer is to promote electron injection and Namiki in no way recognizes that a layer could be used to promote adhesion between a pure Mg cathode and an organic light-emitting layer. If the electron injecting layer disclosed by Namiki did promote adhesion, a pure Mg cathode would be a natural choice because a pure Mg cathode would provide very effective electron injection and there would be little need for an electron injecting layer. The Namiki electron injecting layer is for improving electron injection.

Moreover, Namiki teaches the use of an electron injecting layer of metal oxides, including MgO. Clearly Namiki teaches away from the use of a pure Mg cathode since they do not use it and moreover do not discuss the fact that a pure Mg cathode would have an adhesion problem. Namiki teaches away from the present invention in that their electron injecting layer is for aiding electron injection with a high work function cathode. Adhesion is not mentioned. Namiki discloses the use of a high work function metal cathodes, such as Al, ITO and SnO₂. Mg is a low work function material and a very efficient electron injector. Clearly, Namiki teaches away from the present invention, because the purpose of improving electron injection would be superseded if the electron injecting layer disclosed in Namiki improved adhesion to a substantially pure Mg cathode.

Primarily, the adhesion-promoting layer featured in the present invention has a physically different purpose. The adhesion-promoting layer has the dual-purpose of promoting adhesion between a substantially pure Mg cathode and an organic layer, while maintaining the electron injecting characteristics of the low work function Mg cathode. The advantages of promoting adhesion include the use of a substantially pure Mg cathode, which improves the efficiency, driving voltage and operational stability of the OLED device. As discussed previously, Namiki briefly discusses the use of a Mg cathode but offers no solution to the adhesion problem and therefore the electron injecting layer disclosed in Namiki does not anticipate the adhesion-promoting layer featured in claim 1 of the present

invention. Amended claim 1 is believed to set forth allowable subject matter and subsequently dependent claims 5 and 12-16 are believed to be allowable.

Claims 1, 2, 4 and 12-16 are rejected under 35 USC § 102(b) as being anticipated by Wakimoto (US 5,739,635). It is respectfully submitted that Wakimoto does not anticipate the present invention.

The Examiner stated that the adhesion-promotion layer featured in the present layer was read upon by the Wakimoto disclosure of an electron-injecting layer made of at least one material including Rb, Cs, Rb₂O or Cs₂O and having a thickness of 500 angstroms or less. Applicants respectfully submit that although Wakimoto mentions some of the same materials for the electron-injecting layer, the adhesion-promoting layer featured in the present invention is physically different and not anticipated by the electron injecting layer.

Similar to the previous reference, Wakimoto in discussing the prior art, briefly mention that the cathode can be made of a number of materials including Mg (column 1, lines 45-50). This is just a general discussion in the Background of the Invention and they do not use substantially pure Mg as their cathode in any of the working examples. In every example given in Wakimoto, the cathode is Al, a high work function metal (greater than 4.0 eV). Clearly, the electron injecting layer is to promote electron injection and Wakimoto in no way recognizes that a layer could be used to promote adhesion between a low work function, pure Mg cathode and an organic light-emitting layer. If the electron injecting layer disclosed by Wakimoto did promote adhesion, a pure Mg cathode would be a natural choice because a pure Mg cathode would provide very effective electron injection and there would be no need for an electron injecting layer. The Wakimoto electron injecting layer improves electron injection for high work function cathodes.

Furthermore, Wakimoto is limited to alkaline metal compounds that are insulators with a low work function (column 2 lines 66-67). Wakimoto is concerned with forming an insulating layer between the metal cathode and the organic layer to improve the electron injecting characteristics of a cathode that cannot effectively inject electrons into the organic layer because Al has a high work function (greater than 4.0 eV). Wakimoto is not concerned with the

adhesion problem that is associated with low work function metal cathodes such as Mg. The present invention solves the problem of poor adhesion and removes the need for an electron injecting layer. The present invention features the use of metals or metal compounds from group 1 through group 15 of the periodic table such that the metal has an atomic number of at least 19 in order to form nucleation sites on the organic layer, for Mg atoms to form nuclei at the nucleation sites and subsequently have superior adhesion to the organic layer. The present invention removes the need for an electron injecting layer by allowing superior adhesion between a pure Mg cathode and an organic layer.

Moreover, Wakimoto teaches away from the use of a pure Mg cathode since they do not use it and moreover do not discuss the fact that a pure Mg cathode would have an adhesion problem. Mg is a low work function material and a very efficient electron injector. Clearly, Wakimoto teaches away from the present invention, because the purpose of improving electron injection would be needless if the electron injecting layer disclosed in Wakimoto improved adhesion to a substantially pure Mg cathode.

Primarily, the adhesion-promoting layer featured in the present invention has a physically different purpose. The adhesion-promoting layer has the purpose of promoting adhesion between a substantially pure Mg cathode and an organic layer, while maintaining the electron injecting characteristics of the low work function Mg cathode. The advantages of promoting adhesion include the use of a substantially pure Mg cathode, which improves the efficiency, driving voltage and operational stability of the OLED device. As discussed previously, Wakimoto briefly discusses the use of a Mg cathode but offers no solution to the adhesion problem and therefore the electron injecting layer disclosed in Wakimoto does not anticipate or suggest the use of the adhesion-promoting layer featured in claim 1 of the present invention. Amended claim 1 is believed to set forth allowable subject matter and subsequently dependent claims 2, 4 and 12-16 are believed to be allowable.

Claims 1-6 and 9-16 are rejected under 35 USC § 102(e) as being anticipated by Nakamura et al. (US 6,509,109). It is respectfully submitted that

Nakamura et al., hereinafter referred to as “Nakamura”, do not anticipate the present invention.

The Examiner stated that the adhesion-promotion layer featured in the present layer was read upon by the Nakamura disclosure of an electron-injecting region of the first embodiment made of reducing dopant including alkali metals, alkaline earth metals, rare earth metals, alkali metal oxides, alkali metal halides, alkaline earth metal oxides, alkaline earth halides and rare earth metal oxides (column 7, lines 29-34). The electron injecting region disclosed in the first embodiment of Nakamura includes host organic complexes of aromatic compounds. Amended claim 1 of the present invention does not use a co-doping technique to form the adhesion-promoting layer and further does not contain organic materials. Clearly, the electron injecting region disclosed in Nakamura does not anticipate the present invention. Amended claim 1 is believed to set forth allowable subject matter and subsequently dependent claims 2-6 and 9-16 are believed to be allowable.

The Examiner further stated that the interlayer of an additional embodiment of Nakamura anticipated the adhesion-promoting layer of the present invention. It is respectfully submitted that the adhesion-promoting layer is not anticipated by the Nakamura disclosure of an interlayer.

The Examiner specifically cited that the interlayer disclosed in Nakamura included alkaline earth compounds such as BaO and SrO having a thickness between 0.1 nm and 10 micrometers. The present invention features an adhesion-promoting layer disposed between a substantially pure Mg cathode and a pure organic electroluminescent medium. The interlayer disclosed in Nakamura is disposed between the cathode and the electron-injecting region. The interlayer is not in contact with pure organic electroluminescent medium. Clearly, the interlayer is disposed in a different region for a different purpose and does not anticipate the adhesion-promoting layer featured in the present invention. Amended claim 1 is believed to set forth allowable subject matter and subsequently dependent claims 2-6 and 9-16 are believed to be allowable.

Claims 1-3, 6, 9, 10 and 12-16 are rejected under 35 USC § 103(a) as being unpatentable over Kido et al. (US 6,013,384). It is respectfully submitted that amended claim 1 is unobvious in light of Kido et al.

The Examiner specifically stated that Kido et al., hereinafter referred to as “Kido”, teach the use of a metal-doped layer and refers in the background art to Mg cathodes, from which it would have been obvious to produce the adhesion-promoting layer on the substantially pure Mg cathode featured in the present invention.

Applicants believe that Kido teaches away from the present invention. Kido discloses the use of a metal-doped organic layer adjacent to an aluminum cathode or a metal alloy cathode to improve the electron injecting characteristics of aluminum cathode or metal alloy cathode. Amended claim 1 of the present invention explicitly omits the use of organic materials in the adhesion-promoting layer. Kido teaches an improvement upon the use of OLEDs that use aluminum cathodes or metal alloy cathodes. Kido does not teach a solution to the adhesion problem associated with substantially pure Mg cathodes.


The Examiner stated that the use of Mg as an efficient electrode material is well known in the art. While this is true, the metal-doped organic layer combined with the metal alloy cathode disclosed in Kido does not teach, and would not suggest, the adhesion-promoting layer featured in the present invention. Applicants do not believe that the teaching of a metal doped organic layer on a metal alloy cathode would teach or suggest the use of the an adhesion-promoting layer having at least one metal or metal compound selected from group 1 through group 15 of the Periodic Table of Elements such that the metal has an atomic number of at least 19 in order to create nucleation sites for improved adhesion of a substantially pure Mg cathode.

It is believed that these changes now make the claims clear and definite and, if there are any problems with these changes, Applicants’ attorney would appreciate a telephone call.

In view of the foregoing, it is believed none of the references, taken singly or in combination, disclose the claimed invention. Accordingly, this

application is believed to be in condition for allowance, the notice of which is respectfully requested.

Respectfully submitted,



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